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(54) Abstract Title
Multi-component mixing and dispensing apparatus with pump reversal on switch off

(57) Apparatus for mixing and dispensing a resin made up of two components comprises reservoirs 1 with associated gear pumps 2 which feed the resin components through tubes 3 to a hand-held static mixing head 4,5 having a dispensing tip 6. The pumps reverse a small number of turns after being switched off so as to suck back excess resin. The reservoirs are in the form of bellows which become depressed as the components are withdrawn therefrom. The apparatus can be used for manually applying coloured resins to form stained glass windows designs, in XYZ plotters, or laminating sheets of glass or plastics.

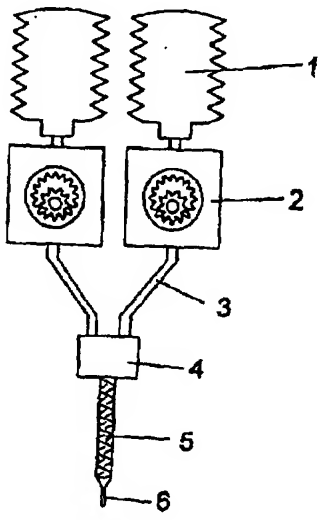

Fig. 1

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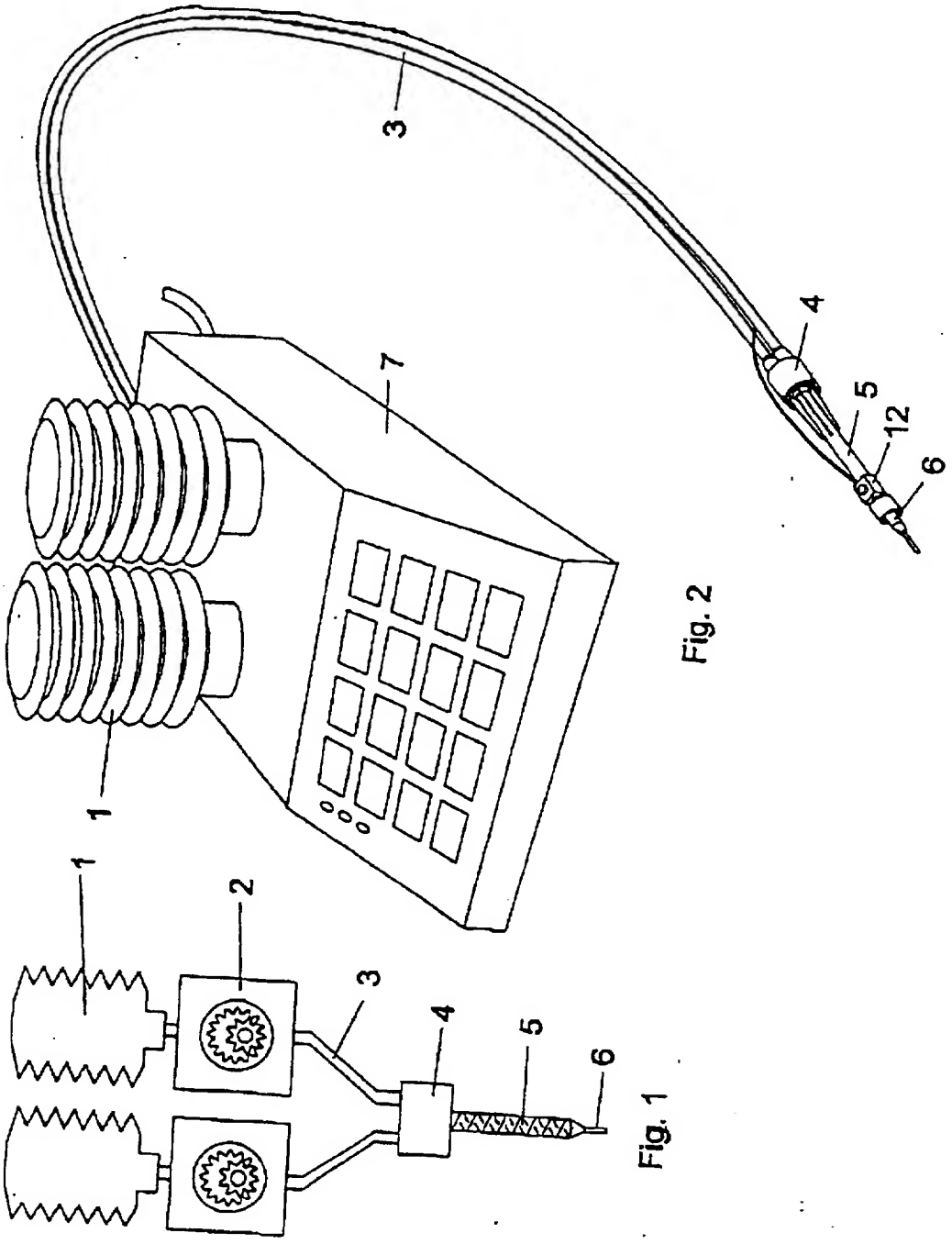

Fig. 2

Fig. 1

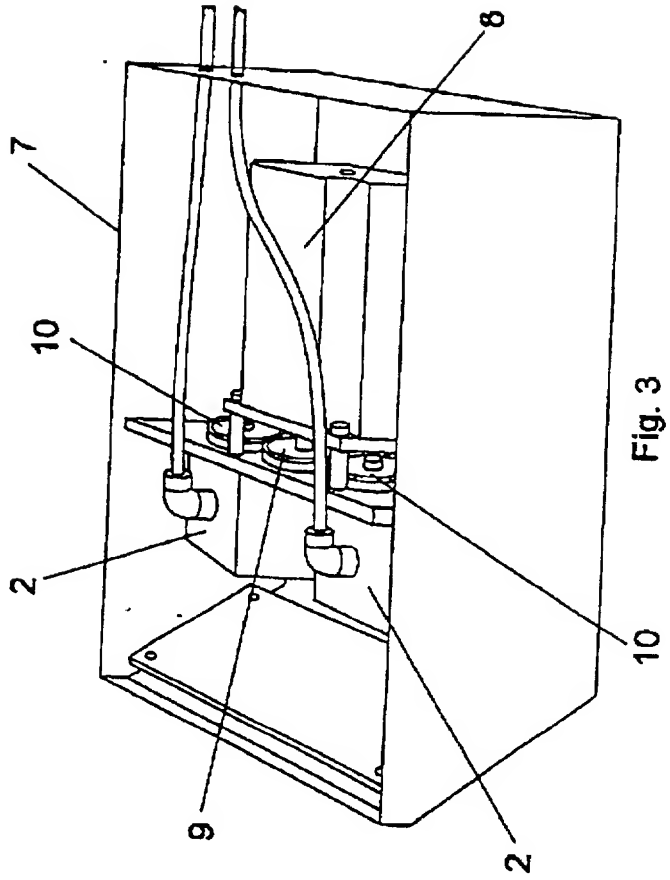

Fig. 3

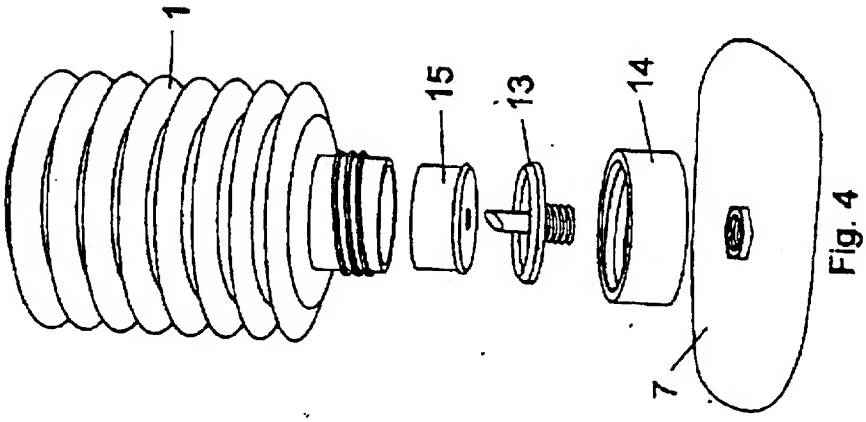

Fig. 4

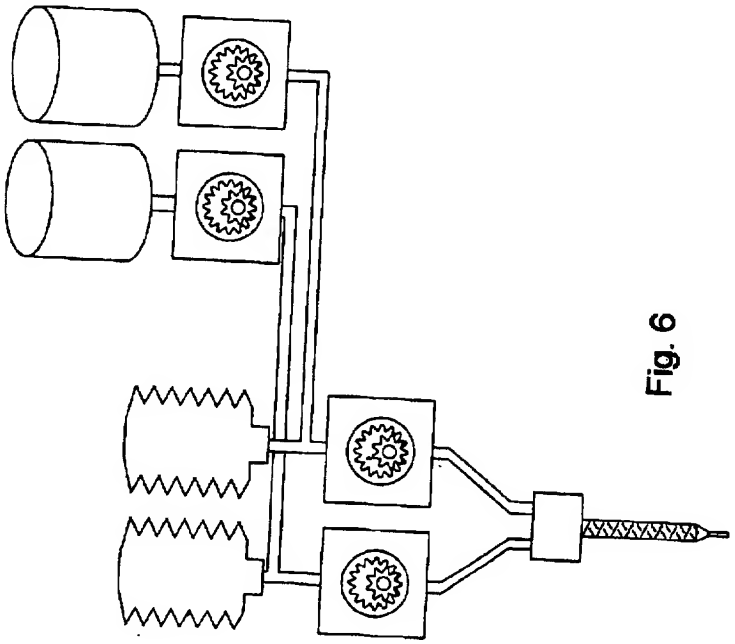

Fig. 6

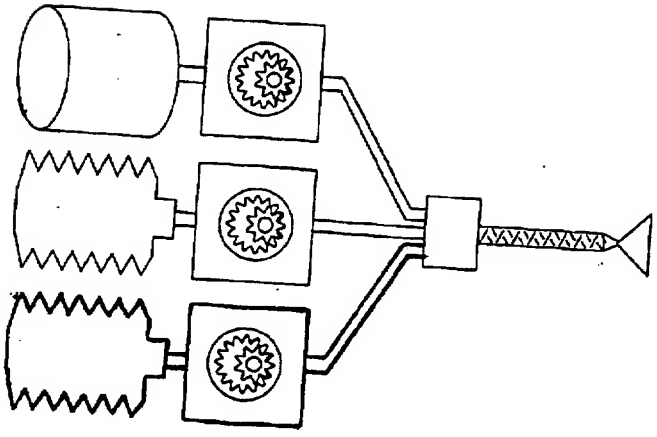

Fig. 5

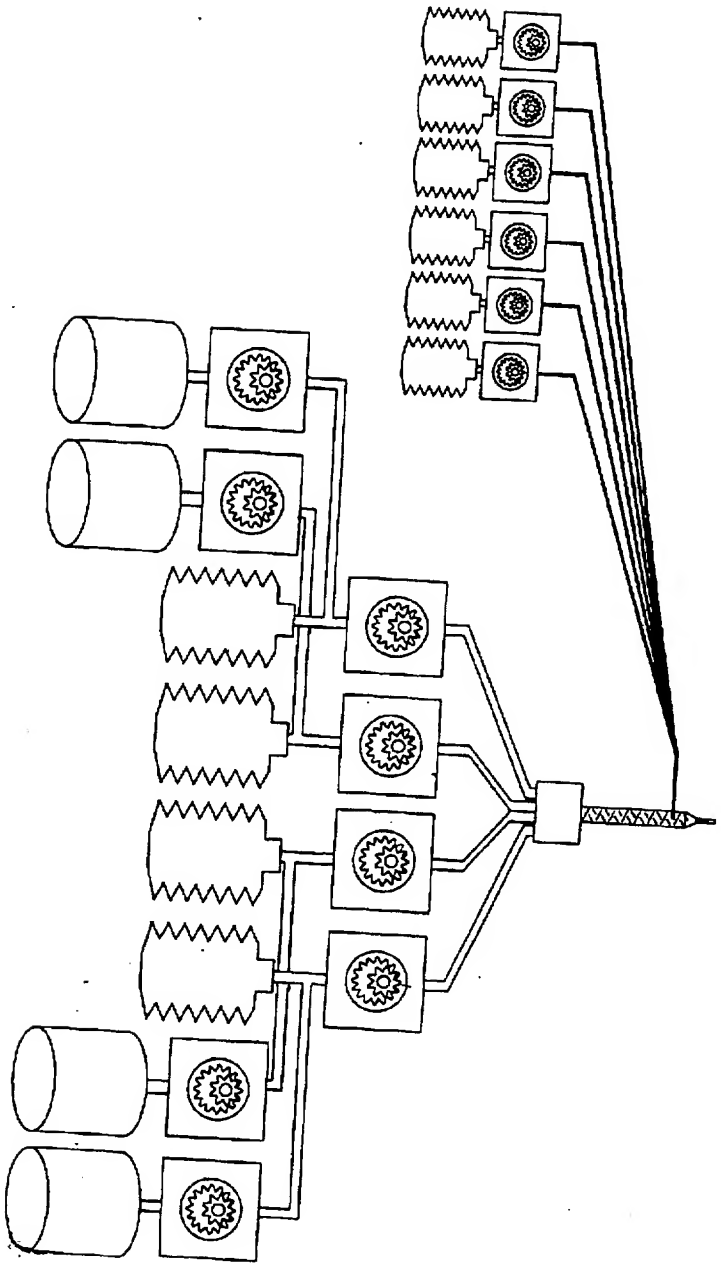

Fig. 7

MULTI-COMPONENT MIXING AND DISPENSING APPARATUS

The present invention relates to an apparatus for mixing two or more components and dispensing the mixed substance.

The invention is particularly, but not exclusively, concerned with mixing two or more components which, when combined, cure as a resin or adhesive or other curable substance. There are several existing systems for mixing, on a large, industrial scale, a number of components drawn from separate containers. Some of these systems use positive displacement pumps for each container of substance to be mixed. The pumps are motor driven, to draw the components from the respective containers into a mixing device. The mixed substance is then dispensed via a dispenser in a manner appropriate to the respective application.

These large systems are not useful for small scale jobs, since, amongst other things, the substances may set or harden in the system if they are not all used in a single job. This leads to waste and requires costly and time-consuming cleaning of the system. Furthermore, such large, industrial mixing and dispensing machines are, in themselves, costly and are not easily portable. Such machines also consume a large amount of energy.

There are many applications in which two-component materials are used as adhesives, paints, etc. as these cure faster and/or are of better quality than one-component material. There are also three or more-component materials used for special applications. 3M, for example, have a two-component adhesive sold in twin syringes with plungers, when pressed down both cylinders dispense into static mixer. This system is also used for glues, in small industries, operated by hand or pneumatically.

There are many applications which require, for example, two-component resins to be mixed in small

quantities and to be dispensed in a precise and defined manner.

One particular application is painting on glass, for example to form stained glass-effect window designs and signs, etc.

In these applications, a continuous, constant flow of mixed resin must be dispensed in a precise pattern. However, generally, only relatively small quantities of mixed resin are required for any particular job.

In the particular application mentioned above of simulating stained and leaded glass, a two-component resin system is used comprising a viscous resin having a thick consistency, and a very thin, transparent resin. The viscous resin is used to make an outline of a desired image which simulates the lead of stained glass. This viscous resin is formed by mixing two components in equal proportions by hand. The mixed resin is then transferred into a plastic squeeze bottle and is then squirted out, by applying pressure to the bottle, onto the glass sheet. Usually, a drawing of the desired image is placed underneath the glass. By gently squeezing the bottle and following the drawing, a design can be formed on the glass. The resin is formed of two components which, when mixed, cure reasonably quickly.

Colour may then be applied to the glass within the outline. The colouring is done by mixing the components of the thin transparent resin in a ratio of 5:2 and adding one or more colour concentrates to obtain the desired colour. The fill-in colour may be applied using a pipette.

Whilst this system is very convenient and easy to use and produces attractive designs, it is not particularly suitable for making exactly straight lines, precise circles, text, logos and exact identical images required in, for example, sign writing.

The present invention aims to provide a mixing and dispensing system for producing a continuous constant

flow of resin which can be dispensed in a very precise manner.

The invention comprises two or more fluid reservoirs each containing a fluid component; two or more pumps one pump associated with each reservoir; means for driving the pumps to convey the fluid components separately to a mixing head; means for mixing the fluids and means for dispensing the mixed fluid.

According to one aspect of the invention, there is provided an apparatus for mixing and dispensing a fluid comprising a first fluid reservoir, a first fluid pump having an inlet port and an outlet port, said inlet port being in fluid communication with said first reservoir, a second fluid pump having an inlet port and an outlet port, said inlet port being in fluid communication with said second reservoir, means for driving said pumps,said means for drdiving being in the form of one or more motors; a mixing head, a first tube for fluid communication between the outlet port of the first pump and the mixing head, a second tube for fluid communication between the outlet port of the second pump and the mixing head, and a dispensing tip through which mixed fluid is dispensed; said apparatus further comprising means for switching said motor on and off, and means for causing said motor to reverse a small number of turns after being switched off.

According to another aspect of the invention, there is provided an apparatus for mixing and dispensing of fluid comprising two or more fluid reservoirs and two or more pumps, one pump being associated with each reservoir, further comprising means for driving the pump to convey fluid from the reservoirs to a mixing and dispensing head; and wherein one or more of the reservoirs is in the form of a cylindrical collapsible container having a closed end and an open end, the cylindrical walls of the container having a concertina or bellows structure allowing the container to become

compressed in height as fluid is drawn from the container.

In accordance with another aspect of the invention, there is provided an apparatus for mixing and dispensing of fluid comprising two or more fluid reservoirs and two or more pumps, one pump being associated with each reservoir, further comprising means for driving the pump to convey fluid from the reservoirs to a mixing and dispensing head; and wherein the mixing and dispensing head is adapted to be driven by a program controlled XYZ plotter adapted to move the mixing and dispensing head in a predefined pattern according to a program.

According to a further aspect of the invention, there is provided an apparatus for mixing and dispensing of fluid comprising two or more fluid reservoirs each containing a fluid component: two or more pumps, one pump associated with each reservoir; means for driving the pumps to convey the fluid components separately to a mixing head; means for mixing the fluids and means for dispensing the fluid; wherein power is provided to the means for driving the pump by one or more batteries installed in a housing containing the two or more pumps and the means for driving the pump.

Preferred embodiments of the invention will now be described, by way of example only, with reference to the accompanying drawings.

Fig. 1 shows a schematic view of a simple system according to the present invention.

Fig. 2 is a perspective view of one embodiment of the invention.

Fig. 3 is a schematic view of the pump and motor mechanism inside the housing of the embodiment shown in Fig. 2.

Fig. 4 is an exploded view showing the connection of a preferred type of container to the housing of an embodiment as shown in Fig. 2.

Figs. 5, 6 and 7 show alternative embodiments of a

system according to the present invention.

Fig. 1 shows a basic device separating according to the present invention. The embodiment shown in Fig. 1 is for mixing two components and, therefore, comprises two containers 1 - one container for each component.

Each container 1 has an associated small gear wheel pump 2 connected to draw the component from the respective container 1. Tubes 3 are connected to the output of the pumps 2. The other end of each of the tubes 3 is connected to a mixing/dispensing head 4 to which is attached a standard static mixer 5 with a dispensing tip 6.

The pumps, when operated, draw the resin components out of the containers and pump it to the mixing tip, via the respective tubes 3. The two components are therefore kept separate until they are combined in the actual dispensing head. The components are then mixed together in the static mixer just before they are dispensed onto the glass via the dispensing tip 6. This prevents the components mixing together and curing too soon which may lead to the system clogging up, if only a small amount of resin is required. In that case, the entire system would need to be cleaned or replaced.

The pump mechanisms and controls are arranged in a compact housing 7 and the containers 1 are mounted on top of the housing in fluid communication with the pumps 2 inside the housing 7.

One small gear wheel pump 2 is associated with each fluid container 1. Each pump has an input port connected to the outlet of its associated container, and an output port, to which an outlet tube 3 is connected. The pumps are operated by a motor 8 to draw fluid from the respective container 1 and to pump the fluid through a respective tube 3, in a continuous flow, to the mixing and dispensing head 4. The pumps are, in the most simple embodiment, small pumps which require only a low wattage motor to run them.

In a simple arrangement in which the two components are mixed in equal proportions, the two pumps 2 may be driven by a single motor 8. The preferred motor is a small DC rotary motor which rotates a toothed gear wheel 9 which engages with a gear wheel 10 of each of the pumps 2 so as to rotate the respective pump gear wheels at the same speed to drive the pumps. In other embodiments, the pumps may be driven by a stepper motor, a servo motor or some form of feedback motor, all of which can be advantageous.

In systems where the components are not to be mixed in a ratio of 1:1, various methods are available for mixing in unequal proportions.

For example, each pump can be driven by a separate motor, operating at different speed, such that the pumps are driven to pump the respective fluids at different speeds.

Alternatively, for a system intended to always mix fluids in a given, unequal, ratio, the two pumps 2 may be driven by the same motor but the pumps may be different sizes, or the gear wheel arrangement may be such that the gear ratio of the motor to one pump is different to that of the motor to the other pump.

In the simplest arrangement, the motor may be controlled in a simple on-off switch provided, for example, on the front of the pump housing 7 or on the mixing/dispensing head 4.

Alternatively, the motor may be controlled by means of a microprocessor and an electronic control circuit. In this preferred arrangement, the microprocessor can be programmed with, for example, pre-set speeds and pumping amounts and/or times. In addition, or alternatively, dials or knobs may be provided on the outside of the pump housing 7 to allow the pump speeds and/or time or quantity to be set and/or varied.

Where a microprocessor is used, a keypad may be provided on the housing to change and store pre-defined

pump speeds and/or amounts. A display may also be provided on the outside of the housing 7 to display the selected settings.

The use of a microprocessor control system allows the system to be expanded by the addition of various extra options, if necessary.

The power for the system may be provided by an internal power supply, a power adaptor for use with a mains power supply or even by the use of batteries fitted into the housing.

The system may also have an optionally enabled serial communication port for connecting with a computer for saving/restoring various design configurations and control functions.

As discussed above, the present system is particularly useful for relatively small, precise jobs, in particular for copying stained glass designs. In such designs, it is important to be able to control the flow of mixed resin or fluid to avoid resin being dispensed in places other than those required.

One problem with existing systems is that some fluid continues to flow to the dispensing tip even after the pumps have been switched off, as the resin in the tubes and the mixer will have built up pressure and this will cause the resin to flow on for a short time after switching the pumps off, until the pressure is gone. When the pump starts again, there will be a delay to build up enough resin to start dispensing. This makes it difficult to accurately dispense resin or fluid.

One possible solution is to program the electronic control system to switch off the pumps slightly early, i.e. a little before the dispensing is to be stopped and to switch the pumps on slightly before dispensing is to commence. However, it is still difficult to produce a very precise dispensing of fluid in this manner. Further, because the dispensing speeds are increasing or decreasing at these times, the width of the line of

resin dispensed onto the glass, etc. will not be uniform.

Another possibility is to provide a valve in the dispensing/mixing head which would close the dispensing/mixing head and, at the same time, decrease the dispensing tip volume to immediately stop dispensing. This solution would, however, have the disadvantage of making the overall system bigger and heavier and the valve would require cleaning after using the system.

In the preferred embodiment of the present invention, this problem is solved by controlling the motor to reverse a few turns at the end of the bead or line of resin to stop the flow of resin by pumping back. Before starting a new bead or line of the pattern, the system may be primed again by pumping a few fast turns.

The separate fluids or components are pumped by the pumps from the respective containers 1 to the mixing/dispensing head 4, via separate tubes 3. Each tube 3 is connected at one end to a respective pump 2, and at the other end to dispensing/mixing head. In one embodiment, the tubes are 2 metre long flexible tubes each of only 4 mm diameter.

The fluids are pumped along the length of the tube and are finally combined in the dispensing/mixing head 4.

In the simplest embodiment, the dispensing/mixing head 4 is a small hand-held unit incorporating a standard static mixer 5.

The mixer 5 is detachably attached to a connector part of the dispensing/mixing head 4 provided at the end of the tubes 3. The mixer 5, which is a small plastic, inexpensive disposable component, can, therefore, be easily detached from the system and replaced. As the two components are kept separate throughout the rest of the system, they do not cure other than in the static mixer, the system can easily be cleaned between

applications, and the static mixer can merely be replaced by a new mixer.

The static mixer is preferably in the form of a spiral mixer having a series of left-hand and right-hand helical elements which progressively divide and recombine the pumped fluids to provide a uniformly mixed output. Such a mixer is capable of thoroughly mixing materials of very different viscosities without introducing any air. This eliminates the need for de-gassing allowing immediate dispensing and greatly improving material flow.

Alternatively, a purpose-designed mixer may be used.

Switches and/or sensors to start/stop the pump, regulate the pump speed, the amount of pumping back and/or the mixed liquid to be dispensed, may be provided on the mixing head connector part. Furthermore, the mixing head may include valves to close off the unmixed liquid supply in such a way that the pressure inside the mixing chamber is released immediately.

The dispensing end of the static mixer may be formed as a dispensing tip. Alternatively, the end of the mixer may be provided with a connector arrangement or luer lock fitting to allow dispensing tips or nozzles of various sizes to be attached.

A switch e.g. a small on/off button 12 may be provided near the dispensing tip. This allows the user to hold the mixer/dispensing tip arrangement by hand, like holding a pen, and to switch the motor on and off by pressing the button. Thus, the outline of the design etc., can be formed by pressing the button and "drawing" the pattern using the dispenser like a pen. This is a lot easier than squeezing bottles, as in the prior art, but is a lot less expensive than using a computerised plotter. The arrangement also provides a uniform, correctly mixed resin.

The dispensing head may be provided with a pressure

sensor (not shown) enabling a continuous adjustment of the pumping speed.

This arrangement is particularly useful for forming the outlines of stained glass type designs which simulate the lead of leaded windows.

Alternatively, rather than using the mixer/dispenser like a pen to draw the pattern, the mixed fluid may be dispensed into cups or containers. This arrangement may be used for forming the thinner, coloured resins used in stained glass design. A mixed resin can be mixed with colour concentrates, using a pipette, in the cup or container, the mixed resins then may be used to fill outlines made with the above-described system.

For particularly fast curing resins, the microprocessor can be programmed to flush the static mixer and dispensing tip before it becomes blocked by cured resin and the operator is not actually using the system but wants the system on standby.

The containers or reservoirs 1 for the different components may be of any readily available type. For example, the containers may be open at the top and filled up from tins containing the various components. One problem with such containers is that the solvents from the components may evaporate producing unpleasant, or possibly even toxic fumes. Some resins can oxidise or react with vapours in the air and, when topping up the containers, air may become trapped in the resin, creating inconsistences in start and stop positions.

To overcome these problems, the preferred embodiment of the invention uses a novel type of container, specially developed for use with the present invention. The containers are in the form of a plastic "bellows" type bottle. The bottle is closed at one end and has a neck, with an opening, at the other end. The walls of the containers have a concertina or bellows form. The neck part of the bottle is attached to the

top of the pump housing 7, such that fluid may flow from the container 1, through a hole in the top of the pump housing 7, through the pump.

Fig. 4 is an exploded view of the preferred "bellows" type container and its attachment to the pump housing 7.

A hole is provided in the top of the housing 7 which communicates with the input port of the pump 2. A hollow shaft having an inner screw thread extends through the hole in the top of the housing 7 into the pump 2 and the end of the shaft protruding from the top of the housing is provided with a nut that abuts against the surface of the housing 7.

A sealing member in the form of a metal disk 13 having a shaft extending from each face is provided. The disk 13 is dimensioned and shaped to fit in a sealing manner against the open neck of the container 1.

A communicating hole is provided in the middle of the disk 13. A conduit shaft extends from this communicating hole from one face of the disk, such that, when assembled, the shaft extends into the interior of the container 1 and provides a conduit for passage of the fluid from that container.

The shaft extending from the other face of the disk 13 has an outer thread adapted to engage with the inner thread of the hollow shaft extending through the pump housing 7. Thus, fluid can be drawn from the container 1, through the hole in the disk 13 via the shafts on each face, and through the pump.

The neck of the container 1 is provided with an outer thread. A retaining collar 14, provided with an inner thread matching the outer thread of the neck of the container 1, is provided to detachably attach the neck of the container to the top of the pump housing 7 by screwing, as shown.

This arrangement provides a secure mounting of the containers 1 onto the pump housing but allows them to be

easily removed and replaced.

As the fluid is pumped from the containers 1, they will be contracted or drawn down until they are empty, the height of the container being compressed according to the amount of fluid remaining in the container 1. Partially used bottles can thus stay in place and, like the pumps and tubes to the dispensing head, these will not need cleaning or flushing with solvents as they are filled with only one component. Only the standard disposable mixer is filled with resin that will cure and needs to be replaced or cleaned.

For small systems, these bellows will be all that is needed to provide sufficient fluid components for mixing. For larger systems where the dispensing head needs to be further away from the fluid container, it may be necessary to use a larger container using a regulated pump, keeping the smaller container between pre-defined fill levels.

A system according to the preferred embodiment of the invention, using small pumps and relatively small bellows type containers can have a total size of around 250 x 180 x 100 mm, with two bottles on top. This clearly provides a very compact and portable system which is easy to use.

Whilst the above description relates to a preferred, most simple embodiment of the present invention, a number of variations are also possible, within the scope of the invention.

In another preferred embodiment rather than the dispenser being used like a pen, operated by hand, the system may be used in combination with an XYZ plotter, wherein the movement of the dispensing head over the glass or other surface is controlled by a programmed plotter in accordance with a pre-programmed pattern. The small, compact and light system of the present invention is particularly useful with XYZ tables, since most existing XYZ tables run on a stepper motor which

cannot start and stop quickly if the plotting head is too heavy. If the head is too heavy, the plotter will slow down but overshoot the planned stop position because of the inertia of the mass of the plotting head, thus creating inaccurate designs. In particular, the system may be used in combination with a plotter table normally used for vinyl cutting and routing but incorporating a dispensing tip as described above instead of a knife or router, to create a bead of viscous resin to form copies of stained glass, etc.

In one embodiment, using the pumped system with an XYZ plotting table, the system is essentially the same as described above, but in addition, an extra controlled pump system may be provided to keep the bellows-type containers always filled from larger containers which can be refilled while running the system. The machine may be adapted to switch on and off and to control the speed.

Preferably, the machine will be adapted to control the pump systems such that the pumps will run at a speed proportional to that of the plotter head. In one embodiment, the pump system can continuously adjust the pump speed to the movement speed of the dispenser tip, thus guaranteeing a constant bead width.

A further embodiment of the invention may allow one or more two-component resins to be mixed with one or more concentrated colours. This would make it unnecessary to clean the pump system or to use the second system for applying different colour outlines. The pump system would then require containers and pumps for each component of the resin and for each concentrated colour. Again the pump may be controlled by an XYZ plotting machine.

In another application, the system may be used for mixing a two or three component resin and injecting this between two or more sheets of glass and/or other material e.g. acrylic or polycarbonate material. This

system can be used to produce laminated sheets by mixing the necessary components and colours using a static mixer and filling the cavity using a purpose built or standard tip.

The sheets are taped together on the edges with a double-sided tape of constant thickness, or sealed at the sides using spacers to separate the sheets. The resin components will be provided in relatively large drums or bottles and, from these, will be tubed to a pump for each component. Pumps will then be tubed to the dispensing/mixing head with static mixer attached as attached above. The dispensing tip is inserted into the double-sided tape so that the resin can be pumped into the space between the glass sheet. The pump will preferably be controlled by a microprocessor and will have a display and keypad to enter glass sizes, etc. to calculate the amount of resin to be dispensed.

One of the sheets may be in the form of a mould so as to produce a 3D surface laminated onto the other sheet.

When laminating, one of the components is a relatively aggressive acid. Therefore, the pump must be specially suited to such application. The pump may be for example, a stainless steel internal gear pump or, perhaps a cylinder or syringe.

With all of the embodiments described above, electronic circuitry and sensors may be provided to control mixing ratios, fill levels, pump speeds and directions, pumped quantities, valves etc. and also to keep a log of the system usage, if necessary. This circuitry may also be used to provide an interface to other systems e.g. microcomputers and PCs, for continuous control and/or logging of the functions of the pump system and saving/adjusting configuration data.

The material used for the pumps may be selected according to the type of resin used. The pumps may be made of, e.g., stainless steel, brass, plastic, ceramic

or other suitable material.

For example, for aggressive resins, the pumps can be made from stainless steel and provided with Teflon® seals, or, in certain circumstances, cylinder pumps or syringes may be used for such resins.

The present invention provides a dispensing pump which can produce a continuous flow of resin whilst preventing pre-mixing of the resin by keeping the components separate until they reach the actual dispensing head. The system is small, compact and light, making it portable and suitable for hand-held use as well as for automatic XYZ plotter use.

The system can be precisely controlled allowing accurate and uniform pattern to be produced of different resin types.

The system works on relatively low pressure, there will be no resin bypass inside the pump and the pumps can be used to dispense precise amounts and mixed in precise ratios. By using internal gear pumps, the precision of the dispensing system can be improved using a minimum of parts.

As the components are only mixed in the disposable mixer only this part needs to be replaced or cleaned.

Whilst the present invention is particularly useful as a small, compact system it can be adapted for larger scale use and still provides advantages over existing systems in that it has fewer parts, requires almost no cleaning and can produce very accurate "shots" of resin by using the microprocessor to stop the pumps after the given amount of steps.

Claims

1. Apparatus for mixing and dispensing a fluid made up of two components comprising two or more fluid reservoirs each containing a fluid component; two or more pumps one pump associated with each reservoir; a mixing head; means for driving the pumps to convey the fluid components separately to said mixing head; means for mixing the fluids and means for dispensing the mixed fluid.

2. Apparatus as claimed in claim 1, comprising a first fluid reservoir, a first fluid pump having an inlet port and an outlet port, said inlet port being in fluid communication with said first reservoir, a second fluid pump having an inlet port and an outlet port, said inlet port being in fluid communication with said second reservoir, a first tube for fluid communication between the outlet port of the first pump and the mixing head, a second tube for fluid communication between the outlet port of the second pump and the mixing head, and a dispensing tip through which mixed fluid is dispensed; wherein each pump is driven by a motor, and wherein said apparatus further comprising means for switching said motor on and off, and means for causing said motor to reverse a small number of turns after being switched off.

3. Apparatus as claimed in claim 2, wherein both pumps are driven by the same motor.

4. Apparatus as claimed in claim 2, wherein both pumps are driven by separate motors.

5. Apparatus as claimed in claim 1 having three or more reservoirs, each having an associated pump, and wherein each pump is driven by a motor, and wherein two

or more of the pumps are driven by the same motor, or all pumps are driven by separate motors.

6. Apparatus as claimed in any preceding claim, wherein one or more of the fluid reservoirs is in the form of a cylindrical collapsible container having a closed end and an open end, the cylindrical walls of the container having a concertina or bellows structure allowing the container to become compressed in height as fluid is drawn from the container.

7. Apparatus as claimed in any preceding claim, wherein the mixing and dispensing head is adapted to be driven by a program controlled XYZ plotter adapted to move the mixing and dispensing head in a predefined pattern according to a program.

8. Apparatus as claimed in any preceding claim, wherein power is provided to the means for driving the pump by one or more batteries installed in a housing containing the two or more pumps and the means for driving the pump.

9. Apparatus as claimed in any preceding claim, further comprising means to enable each pump to be driven at a different speed.

10. Apparatus as claimed in claim 9, wherein said means for enabling each pump to be driven at a different speed comprises an arrangement of gears.

11. Apparatus as claimed in claim 9, wherein said means for enabling each pump to be driven at a different speed comprises a microprocessor.

12. Apparatus as claimed claim 9, wherein said means for enabling each pump to be driven at a different speed

comprises manually adjustable control knobs or buttons operable by the user.

13. Apparatus as claimed in any preceding claim further comprising means for varying the dispensing speed.

14. Apparatus as claimed in any preceding claim further comprising an optionally enabled communication port allowing a connection with a computer.

15. Apparatus as claimed in any preceding claim, wherein the mixing head is in the form of a static spiral mixer having a series of left and right hand helical elements which progressively divide and recombine the pumped fluids to provide a uniformly mixed output.

16. Apparatus as claimed in any preceding claim, wherein a valve arrangement is provided in the mixing head to close off the unmixed fluid supply in such a way that the pressure inside the mixing head is released immediately.

17. Apparatus as claimed in any preceding claim wherein said means for dispensing includes a pressure sensor.

18. Apparatus as claimed in any preceding claim wherein said means for dispensing is in the form of a pen type dispensing head.

19. Apparatus as claimed in any of claims 2 to 18 wherein the motor(s) is/are in the form of a DC motor.

20. Apparatus as claimed in any of claims 2 to 18 wherein the motor(s) is/are in the form of a stepper motor.

21. Apparatus as claimed in any of claims 2 to 18 wherein the motor(s) is/are in the form of a servo motor.

22. Apparatus as claimed in any of claims 2 to 18 wherein the motor(s) is/are in the form of a feedback motor.

23. Apparatus as claimed in any preceding claim, further comprising a main supply reservoir for each fluid, connected via respective supply lines to the fluid reservoir for the same fluid, and further comprising pump means for pumping fluid from the main supply reservoirs to the fluid reservoirs.

24. A method of laminating comprising the steps of mixing a multiple component resin using the apparatus of any of the preceding claims and injecting the mixed resin from the dispensing means between two sheets of material to be laminated.

25. The method of claim 24, comprising providing two sheets of glass, acrylic or polycarbonate material with a cavity formed therebetween and injecting the mixed resin into the cavity.

26. Apparatus substantially as hereinbefore described, with reference to the accompanying drawings.

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Application No:	GB 9906841.3	**Examiner:**	Graham Russell
Claims searched:	1-26	**Date of search:**	26 April 1999

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Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.Q): B1C (CAGA)

Int Cl (Ed.6): B29B 7/74

Other: Online: EPODOC, JAPIO, WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X	GB 1503904	(FOSROC) see Fig 1	1
Y	EP 110591 A1	(BUSM) see page 5 lines 21-35	2
X,Y	FR 2654011 A	(REXSON) see WPI abstract Acc No 91-224963 [31]	X:1 Y:2
X,Y	US 5005765	(SPECIFIED EQUIPMENT)	X:1,3 Y:2
X,Y	US 4931249	(THERMAL DESIGNS)	X:1,3 Y:2

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.